




Research Article

Multiagent Collaborative Governance for Targeted Poverty Alleviation from the Perspective of Stakeholders

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As a social problem involving a wide range of objects, targeted poverty alleviation governance needs to clearly define stakeholders and identify their behaviour choices, so as to seek a multiagent collaborative governance strategy, and strive to jointly promote the realization of a targeted poverty alleviation goals in an atmosphere to win-win cooperation and benefit sharing. By constructing a three-subject evolutionary game model of local government, social organization, and poverty group in the process of targeted poverty alleviation, this paper discusses the influence of their behavioural decisions on multisubject collaborative governance of targeted poverty alleviation and selects samples to carry out simulation experiments on the model. The results show that, first, superior government support has little effect on the evolution of tripartite competition, and the conclusion is inconsistent with the general cognition. However, the enhancement of support from local governments and social organizations can effectively promote the transformation of the willingness of the poor groups to cooperate. Second, a modest increase in the punishment of social organizations and poor groups can have a binding effect on the behavioural strategy choices of both sides and ultimately promote the process of targeted poverty alleviation. Third, the increase in the benefits of social organizations and poor groups can significantly improve the willingness of both sides to cooperate, so the “endogenous driving force” of the poor groups should be enhanced to achieve the Pareto optimal state of targeted poverty alleviation.

1. Introduction

At the “2015 Poverty Reduction and Development Forum,” President Xi Jinping stated that “we have been committed to mobilizing the whole society to participate, giving full play to China’s institutional advantages, and building a pattern of great poverty alleviation coordinated by the government, society, and market, and forming a social poverty alleviation system with diverse participants that involves cross-regions, cross-departments, cross-units, and the whole society” [1]. To solve the problem of collaborative governance of diverse subjects is the key to poverty alleviation. This not only needs external help from the government and social groups but also needs to rely on the endogenous driving force of the poor groups to get rid of poverty, so as to realize the benign

interaction between “inside” and “outside.” At present, in the process of targeted poverty alleviation, the poor groups are interrelated through the realization of poverty alleviation goals, forming a collaborative network. However, all the subjects, from the perspective of their own interests, do not form synergy through poverty alleviation goals. At present, taking targeted measures to alleviate poverty has gone from “fighting alone” to “unity and cooperation.” It is imperative to create a multidimensional interconnected pattern for collaborative governance by multiple subjects. In fact, in the process of targeted poverty alleviation, no substantial progress and breakthroughs have been made in the collaborative governance of diverse subjects, nor has a systematic and comprehensive collaborative mechanism been formed [2, 3]. Therefore, in order to effectively promote the

new pattern of coordinated governance of multiple subjects in accurate poverty alleviation, it is necessary to find out the key factors that affect each interest subject and clarify the action path of these key factors, so as to ultimately promote the cooperation of each interest subject. Therefore, the main problems to be solved in this paper are as follows:

- (1) Analyze the relationship and game strategy selection between local government, social organizations, and poverty group in the process of poverty alleviation and explore the factors influencing the cooperation evolution of local government, social organization, and poverty group taking the support of the local government as environmental factors.
- (2) Based on the premise of limited rationality, the process precision of poverty alleviation is regarded as a gradual learning process of dynamic construction of precision in the process of poverty alleviation, poverty group in local government, social organization, and the evolutionary game model and found the key influencing factors by setting the parameters and solving the models.
- (3) The stability strategy selection of the three parties in the process of targeted poverty alleviation is studied by analyzing the evolutionary game equilibrium and stability of local governments, social organizations, and poor groups in the process of targeted poverty alleviation. Then, through the changes of the upper government financial support, the benefit of the poverty group, and other parameters, Matlab is used for simulation analysis, which more intuitively reflects the game evolution trend of local governments, social organizations, and poor group in the process of accurate poverty alleviation and puts forward reasonable countermeasures and suggestions to provide decision-making basis for government departments.

In view of this, there are three main differences in this study. First, based on the limited rational perspective of participants, the paper introduces the parameters of government funding, income of poor groups, etc., constructs the evolutionary game model of multiagent collaborative governance for targeted poverty alleviation, and solves the equilibrium strategy. Second, it focuses on the key factors affecting the selection of multiagent collaborative governance strategy. Again, the evolutionary characteristics and evolution trends of the group in the process of precision poverty alleviation and multiagent collaborative governance are observed through simulation. According to this conclusion, it can more accurately and objectively reflect the strategy choice of the game players in reality and has a reference value and guiding significance for the decision-making of multiagent targeted poverty alleviation and collaborative governance.

The rest of the study is arranged as follows. Section 2 discusses the relevant literature of collaborative governance and targeted poverty alleviation and puts forward the innovation of this work. In Section 3, the problem description

of the model and the assumption of related parameters are introduced in detail. Section 4 studies the gradual stability of multiagent through the construction and analysis of income function. Section 5 analyzes the evolution characteristics and trend of the group in the process of multiagent collaborative governance through simulation. Section 6 summarizes the research of this paper and puts forward relevant countermeasures and suggestions.

2. Literature

International experience shows that multiagent coordinated governance can improve the level of poverty. Linkov and Trump denoted the criticality of collaborative and multi-stakeholder governance for major challenges such as poverty [4], while Newman et al. framed collaborative governance as a function of public participation [5]. Linkov's work further unpacks the various notations of collaborative and multi-stakeholder governance for extreme system complexity and uncertainty (Linkov et al.) [6]. Jessoula studied the effectiveness of multiagent collaborative poverty alleviation from the perspective of multilevel social structure in Europe [7]. Khumalo advocated a multistakeholder approach to the challenge of poverty and reconsidered the structural issue of perpetuating poverty [8]. Sharma's innovative financing mechanisms engaging diverse stakeholders for developing poverty reduction strategies have been engineered as possible neoinstitutional structures to counter the world's most daunting problems [9]. Ferdinand et al. illustrated the need for multistakeholder partnerships to reduce vulnerability and enhance the resilience of communities through the Caribbean Sea case [10]. Eberlei pointed out that poverty reduction strategy (PRS) is based on the broad participation of internal and external stakeholders, including parliament, civil society organizations, representatives of the private sector, and other stakeholders at the national and local levels [11].

Most of the research on collaborative governance for targeted poverty alleviation focuses on four aspects, namely, governance dilemma, governance mode, governance path, and governance practice:

- (1) Research on the dilemma of targeted poverty alleviation and collaborative governance: although the holistic governance theory provides an inspiring idea for the innovation of poverty alleviation work mechanism, there is still a dilemma of "fragmentation" in the coordinated governance of targeted poverty alleviation in China. He and Chen [12] pointed out that the local government functions in China and the complexity of the rural poor governance lead to the present situation of fragmentation governance of public services, which in turn makes poverty alleviation and the allocation of resources for poverty alleviation "fragmented." Fu Canliang [13], based on questionnaires and interview data, examined and analyzed the fragmentation of targeted identification, targeted assistance, targeted management, and targeted assessment in the

implementation of targeted poverty alleviation policies. Leng et al. [14] pointed out that, due to information asymmetry, the practice of targeted poverty alleviation in China is faced with three major problems. That is, the moral hazard between governments at all levels and the objects of assistance, disconnection between supply and demand from the public and the objects of assistance, and fragmentation of poverty alleviation caused by non-coordination of multiple subjects. Yang [15] believed that the current rural poverty alleviation work in China is confronted with such problems as the lack of benign interaction between institutions, the lack of collaborative participation among the main bodies of poverty alleviation, the lack of collaborative linkage among functional departments, and the lack of effective integration of poverty alleviation resources and the fragmentation of poverty alleviation work performance evaluation, which affect the poverty alleviation effect.

- (2) Research on the collaborative governance model for targeted poverty alleviation: China's traditional, unidirectional, passive, and extensive mode of poverty management leads to low poverty alleviation efficiency. Zhuang et al. [16] proposed the five-in-one poverty governance model of "government-market-society-community-farmer household", and discussed how to ensure the effective implementation of targeted poverty alleviation from the aspects of accurate identification, assistance, management, assessment, interest connection, and social mobilization. Ma [17] provided new ideas for the implementation of targeted poverty alleviation in the new era by defining the mission of targeted poverty alleviation in industry and government partners, building partnerships, cultivating mutual trust and implementing incentives, and strengthening the government network governance capacity. Xu et al. [18] analyzed the game relationship between the poor, the nonpoor, the local government, and the superior government in the process of precise poverty alleviation and proposed to improve the coordination model among the government, market, and society. Lin [19] proposed to build a diversified poverty alleviation model actively participated by the government, society, and the poor population and to establish and improve the coordination mechanism among poverty alleviation subjects, poverty alleviation resource integration mechanism, and accurate poverty alleviation assessment mechanism. Mo [20] analyzed the targeted poverty alleviation governance model, transformation from the aspects of poverty alleviation, accurate way of poverty alleviation, precise subjects, and precise process and pointed out that an accurate path to break the management of poverty alleviation is to adhere to the people-centered concept, construct the comprehensive full of precision mechanism, refine government-led

diversified participation pattern, and carry out the value orientation of new development concept.

- (3) Research on the path to coordinated governance of targeted poverty alleviation: in view of the plight of targeted poverty alleviation under the framework of collaborative governance analysis, Chinese experts and scholars have made positive and beneficial discussions on its governance path. Xie and Liu [21] analyzed the predicaments of poverty in the inter-provincial marginal regions and pointed out that it was necessary to introduce the holistic governance analysis framework and adopt holistic governance approaches such as constructing the goal orientation, subject structure, institutional system, and cross-border cooperation of poverty governance in the interprovincial marginal regions. Liu and He [22] believed that the current targeted poverty alleviation of the association would gradually go towards the coordinated targeted poverty alleviation, and the realization of the coordinated targeted poverty alleviation required the coordination of poverty alleviation information, the coordination of poverty alleviation system, the coordination of poverty alleviation culture, and the cultivation of good social capital. Shen [23] pointed out that targeted poverty alleviation is essentially a practice of refined social governance, which should also be integrated into governance concepts such as decentralization, cooperation, and participation. Based on the rural system, the government, the public, communities, enterprises, and the object of poverty alleviation should be fully mobilized to solve poverty through factor introduction. He and Liu [24] pointed out that there was a theoretical fit between the multiple coordinated precision, poverty alleviation, and social capital. Good social capital is the premise and foundation for the realization of multiple coordinated precision poverty alleviation, and it is necessary to transform traditional social capital and invest modern social capital to promote the realization of multiple coordinated precision poverty alleviation. Chen and Li [25] proposed the path of targeted poverty alleviation under the collaborative system, which established a cross-precise object identification mechanism, searched for the prevention mechanism of poverty alleviation by equalization of basic public services, and innovated the poverty alleviation mechanism by classification management of multiple subjects.
- (4) Research on the practice of coordinated governance for targeted poverty alleviation: the targeted and holistic governance of poverty alleviation has also made some achievements in practice. Jin and Ding [26] provided empirical evidences for the construction of multiple collaborative poverty alleviation mechanisms of government, market, and society based on the case study of "Jinsha model." Guan [27] took collaborative governance as the analytical

framework, deeply analyzed the prominent influencing factors of targeted poverty alleviation work in Guangxi, and promoted the readjustment and deepening of the mechanism and mode of targeted poverty alleviation work from the aspects of process synergy, system synergy, subject synergy, and technology synergy. Wang and Li [28] believed that it was necessary to coordinate the three poverty alleviation systems of special projects, industry, and society at the two levels of overall promotion and precise individual assistance, so as to find the key path of poverty alleviation and alleviation. Zhan [29], based on the analytical framework of collaborative governance and on-the-spot investigation of *S* village, *T* village, and *R* village, summarized the difficulties in identifying the poverty-stricken marginal groups, realizing the difficult dynamic management, imprecise assistance, insufficient social participation, and material assessment in the targeted rural poverty alleviation, and put forward the future work for causes of trouble of path optimization. Mu and Pan [30] started with the mechanism analysis of government-market poverty alleviation development, combined with the practical cases of poverty alleviation development in Guizhou province, and conducted a preliminary discussion on the government-market double-oriented poverty alleviation development mechanism.

Targeted poverty alleviation (poverty alleviation) has always been the focus of experts and scholars, but relatively few studies have been made on the game in the process of targeted poverty alleviation. (1) The game of poverty alleviation between the government and poor groups or other poverty alleviation subjects. Based on the theoretical perspective of social interaction theory, Fang Jin explored the interactive relationship between the government and social organizations in the field of rural poverty governance by means of the method of cross-comparison analysis in [31]. By establishing the evaluation function of the comprehensive prospect value, Huang Haitang formed a dynamic evolutionary game model between the government and enterprises in the process of poverty alleviation and development and established a reasonable mechanism for poverty alleviation and development by the government and enterprises [32]. Tian et al. analyzed the possible information asymmetry between the government and the poor group, resulting in the emergence of interest conflicts, analyzed the conditions affecting the poverty alleviation cooperation, and tried to find a new poverty alleviation coordination mechanism between the government and the poor group [33, 34]. (2) Poverty alleviation game between multiple subjects. Under the current system of our country, the mode of collaborative poverty alleviation with multisubject participation is gradually formed. It belongs to the stage of participatory poverty alleviation [35] from 2001 to 2010, relying on policies to emphasize participatory assistance [36, 37]. Subsequently, the participants of poverty alleviation policies are gradually extended by local governments, social

organizations, and many other units to implement the mobilization type of poverty alleviation development [38]. At the same time, Liu et al. subdivided the roles of the government into the central government and local government groups, constructed a three-party game between the central government, the local government, and the poor groups, and obtained the strategic profit and loss of each participant in the game [39–43].

It has been proved that the targeted poverty alleviation model featuring multiple linkages involving the participation of poverty groups, governments, and enterprises can promote poverty alleviation, leading to the multisubject poverty alleviation cooperation [44–49]. However, the key problem of multisubject participation in poverty alleviation is to solve the conflict of interest among participants and seek a stable and balanced state. Therefore, the game of poverty alleviation among multiple subjects arises at the historic moment. Yu et al. constructed multiplayer game models based on game theory and analyzed how to formulate a reasonable and scientific accurate poverty alleviation system by using the optimal solution [50–53].

To sum up, in recent years, the research on collaborative governance of multiple subjects has become a hot topic for experts and scholars, and rich research results have been achieved. However, from the perspective of the content of the study, it mainly focuses on the profit and loss analysis of the poverty alleviation strategy involving multiple subjects and does not use game theory to deeply study and solve the conflicts among multiple subjects. In related studies, some scholars have explored the possibility of a collaborative governance models of multiple subjects, but there is still a lack of powerful analytical tools.

3. Problem Description and Parameter Hypothesis

Evolutionary game theory is a theory combining game theory analysis with dynamic evolutionary process analysis, which is defined as a dynamic equilibrium [54]. Nowadays, economists use evolutionary game theory to analyze the influencing factors in the formation of social habits, norms, institutions, or institutions and explain their formation process and have also made remarkable achievements [55–60]. The basic idea of the evolutionary game is that the players are not super rational, and it is impossible to find the optimal equilibrium point in every game. It aims to reach the equilibrium through trial and error by repeated games. Thus, the best strategy for game players is to imitate and improve on the best strategy for themselves and others in the past. Through long-term simulation and improvement, all players tend to a certain stable strategy (as shown in Figure 1).

As described in the evolutionary game model, as a limited rational person, the cooperation and competition between local governments, social organizations, and poverty groups in the process of targeted poverty alleviation need to constantly revise and improve the behavioural strategies through the recognition of the cooperative behaviour rules of targeted poverty alleviation and finally obtain the satisfactory benefits. Therefore, in the practice of

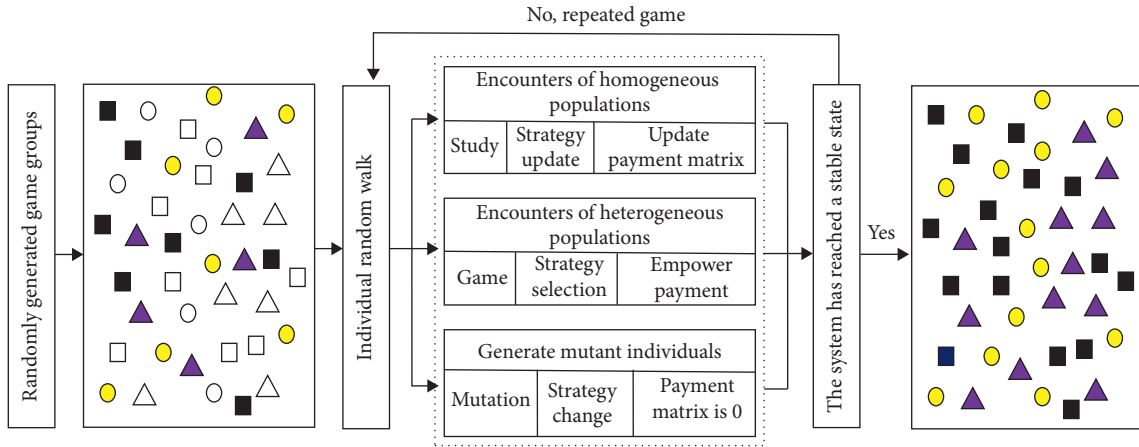


FIGURE 1: Basic idea diagram of evolutionary game.

targeted poverty alleviation, local governments, social organizations, and poor groups are assumed to be rational people who pursue their own independent interest appeals to maximize their own interests. Under the hypothesis of limited rationality, the cooperative governance model of local government, social organization, and poverty group based on evolutionary game can be constructed to study the cooperative relationship and behavioural strategy.

The subjects involved are as follows.

- (1) Local government: local government is defined as the general term of a government organization that manages the affairs of a national administrative region. It is the intermediate link between the central government, provincial government, district-level government, township government, and village government, and it is the basic administrative region for the overall economic and social development.
- (2) Social organization: social organization is one of the three elements of public relations. In a narrow sense, it is a public activity group that achieves a certain goal according to a certain purpose and system. For example, enterprises, factories, schools, and hospitals.

According to the type of organization, social organizations can be divided into four categories. The specific contents are shown in Table 1.

The social organizations studied in this paper belong to the category of competitive profit-making organizations, which will pursue the maximization of their own interests to ensure long-term development.

- (3) Poverty group: poverty group, in the broad sense, refers to an impoverished household and impoverished village.

Generally, according to the definition of the scope of the poverty group, the standard can be divided into Table 2. However, the specific situation should be based on local conditions to visit the investigation, in order to ensure that the specific situation analysis.

3.1. Basic Assumptions. Suppose the game participants and strategies are local government (active cooperation and passive treatment), social organizations (participating in or not participating in poverty alleviation), and poverty groups (active cooperation and passive treatment). There are two behavioural strategies for local government. One is to actively cooperate and comprehensively supervise poverty alleviation. Through self-regulation, social organizations actively participate in poverty alleviation and the poverty groups actively support poverty alleviation. The other is that local governments have taken a passive approach to poverty alleviation with inadequate oversight. There are two behavioural strategies for social organization. One is to actively participate in poverty alleviation and help poverty groups to get rid of poverty as soon as possible. The other is the lack of initiative to help, which means staying out of the situation and failing to play a benign role in the model. Similarly, there are two behavioural strategies for the poverty groups. One is to actively cooperate with the poverty alleviation work of local government and social organizations. The other strategy is that it does not support or cooperate with poverty alleviation work and lacks internal impetus for poverty alleviation.

In addition, local governments, social organizations, and poverty groups are all limited rational persons. In the process of getting rid of poverty, the poor groups pursue the maximization of their own benefits. However, local governments and social organizations need to pay the cost of poverty alleviation in the process of targeted poverty alleviation. If the poverty group is not lifted out of poverty, local governments and social organizations will have to pay a huge cost. Therefore, local governments and social organizations aim to minimize the loss of social benefits. Under the choice of positive and negative treatment strategies of local governments, social organizations and poor groups improve the relevance gains and losses of targeted poverty alleviation through cooperation. Therefore, this paper only studies the situation that social organizations and poor groups will generate negative gains when one party does not cooperate, and the relevance negative gains of local governments at this time can be ignored.

TABLE 1: Classification of social organizations.

Definition	Explanation
Competitive profit-making organization	Usually a competitive profit-making organization consists of a productive, commercial, and service organization; they pursue their own economic benefits in the market competition by establishing a good organizational image to snatch customers, and profit is more obvious
Competitive nonprofit organization	Usually competitive NPOs consist of a variety of professional academic research groups and have almost no profit motive
An exclusive profit-making organization	Generally, an exclusive profit-making organization is defined as an organization that has a large market share in market competition; because of the uniqueness of the products or services it produces, it is difficult for other organizations in its market to compete with it
Exclusive nonprofit organization	Exclusive nonprofit organizations include government agencies and the military

TABLE 2: Definition of the poverty group.

Classification	Specific conditions
Absolute poor	The annual per capita net income is less than 627 RMB
Relatively poor population	Annual per capita net income is between 628 to 865 RMB
Low-income population	Annual per capita net income is between 866 and 1205 RMB
General income and high income	Annual per capita net income is more than 1205 RMB

3.2. Setting of Relevant Income Parameters. Local governments, social organizations, and poverty groups are always relatively stable within a certain region, and the probability of local governments choosing cooperative strategies at t time is $x(t)$, while the proportion of social organizations and poor groups choosing cooperative strategies is $y(t)$ and $z(t)$ respectively, which satisfies $0 \leq x(t) \leq 1$, $0 \leq y(t) \leq 1$, and $0 \leq z(t) \leq 1$.

The game relationship in the coordinated governance of multiple subjects of targeted poverty alleviation is relatively complex. There are both cooperation and competition. The factors affecting the choice of behaviour subjects' strategies involve many aspects. In this paper, the relevant factors of cooperative competition among the government, social organizations, and poverty groups are searched for the literature. The relevant summary is shown in Table 3:

Therefore, according to the existing research results, this paper takes these main factors as the main parameters of the model to build the evolutionary game model of multiagent collaborative governance of targeted poverty alleviation. The relevant benefit parameters are set as follows.

As for the local government, C_1 is the support provided by the superior government for the local government to actively alleviate poverty, such as funds, projects, and special subsidies for poverty alleviation; C_2 is the cost for local governments in the process of targeted poverty alleviation; When the three parties are active in poverty alleviation, the external benefits brought by local governments due to poverty alleviation is C_3 , such as environmental improvement and sustainable industrial development; C_4 refers to the loss of opportunity cost when the local government is active in poverty alleviation but other entities do not cooperate.

As for the social organizations, W_1 refers to the basic benefits brought by targeted poverty alleviation when selecting cooperative strategies for social organizations, such as increased opportunities and economic effects after poverty alleviation; W_2 is the cost for social organizations to choose cooperation in the process of targeted poverty

alleviation, such as the support of time and funds for poor groups to get rid of poverty; W_3 refers to the support to social organizations in choosing cooperation strategies for local governments. At the same time, if social organizations choose noncooperative strategies, negative benefits k_1A_1 , $(1 - k_1)A_1$ will be generated for themselves and the poor groups (the negative benefits include opportunity costs and other losses).

As for poverty groups, S_1 is the basic benefits brought by targeted poverty alleviation when choosing cooperative strategies for poverty groups, such as increased economic income and improved social recognition after poverty alleviation; S_2 refers to the cost of choosing cooperation for the poor in the process of targeted poverty alleviation, such as labour and time; S_3 is the support for poverty groups in choosing cooperative strategies for local governments; S_4 refers to the support given to poor groups in choosing cooperative strategies for social organizations. At the same time, if the poverty group chooses the noncooperative strategy, it will generate negative benefits $(1 - k_2)A_2$, k_2A_2 to social organizations and itself (the negative benefits include opportunity costs and other losses).

3.3. Construction of Payment Function. Based on the above assumptions, the income matrix of local governments, social organizations, and poverty groups can be obtained, as shown in Table 4.

4. Evolutionary Stability Strategy Analysis

4.1. Construction of Revenue Function. Suppose that U_{11} represents the expected return when the local government chooses the cooperative strategy, U_{12} represents the expected return when the local government chooses the noncooperative strategy, and \bar{U}_1 represents the average expected return of the local government. According to the above analysis, there are

TABLE 3: Summary of influencing factors of targeted poverty alleviation and multiagent collaborative governance.

Scholar (year)	Research subject	Influence factor
Feng (2019) [61]	Government and poverty groups	Government: cost of poverty alleviation, social impact, and extraincome in case of negative Poor groups: government subsidies, opportunity costs, and additional government incentives
He (2019) [62]	Government and enterprises in poverty alleviation	Government: income of superior government and people, basic income of government, cost of government support, and loss of government income Enterprise: government subsidy, enterprise investment, government policy support, basic income of enterprise, income from society of enterprise, and loss of enterprise income
Zheng et al. (2019) [63]	Two governments in ecological poverty alleviation	Cost of poverty alleviation, positive benefit of active poverty alleviation, and negative benefit of one party's noncooperation
Huang et al. (2019) [64]	Government and enterprises	Government: subsidy perceived cost, reputation perception, and expectation loss Enterprises: scale effect, government subsidy, and reputation loss
Yao and Liu (2019) [65]	Grassroots organizations, helpers, and poor groups	Incentive strength, additional income, and loss of returning to poverty
Zhang et al. (2019) [66]	Government and social organizations	Government: guide cost, punishment, and reward Social organization: cost and additional income

TABLE 4: Game payment matrix between the three players.

Strategy combination	Local governments	Social organizations	The poverty group
(1, 1, 1)	$C_1 - C_2 + C_3 - W_3 - S_3$	$W_1 - W_2 + W_3 - S_4$	$S_1 - S_2 + S_3 + S_4$
(1, 1, 0)	$C_1 - C_2 - W_3$	$W_1 - W_2 + W_3 - k_2 A_2$	$-(1 - k_2) A_2$
(1, 0, 1)	$C_1 - C_2 - S_3$	$-k_1 A_1$	$S_1 - S_2 + S_3 - (1 - k_1) A_1$
(1, 0, 0)	$C_1 - C_2 - C_4$	$-k_1 A_1 - k_2 A_2$	$-(1 - k_1) A_1 - (1 - k_2) A_2$
(0, 1, 1)	0	$W_1 - W_2 - S_4$	$S_1 - S_2 + S_4$
(0, 1, 0)	0	$W_1 - W_2 - k_2 A_2$	$-(1 - k_2) A_2$
(0, 0, 1)	0	$-k_1 A_1$	$S_1 - S_2 - (1 - k_1) A_1$
(0, 0, 0)	$-C_4$	$-k_1 A_1 - k_2 A_2$	$-(1 - k_1) A_1 - (1 - k_2) A_2$

$$U_{11} = yz(C_1 - C_2 + C_3 - W_3 - S_3) + y(1 - z) \cdot (C_1 - C_2 - W_3) + (1 - y)z(C_1 - C_2 - S_3) + (1 - y)(1 - z)(C_1 - C_2 - C_4), \quad (1)$$

$$U_{12} = (1 - y)(1 - z)(-C_4), \quad (2)$$

$$\begin{aligned} \bar{U}_1 &= xU_{11} + (1 - x)U_{12} = xyz(C_1 - C_2 + C_3 - W_3 - S_3) \\ &+ xy(1 - z)(C_1 - C_2 - W_3) + x(1 - y)z \\ &\cdot (C_1 - C_2 - S_3) + x(1 - y)(1 - z)(C_1 - C_2 - C_4) \\ &+ (1 - x)(1 - y)(1 - z)(-C_4). \end{aligned} \quad (3)$$

Suppose that U_{21} represents the expected return when social organizations choose cooperative strategy, U_{22} represents the expected return when social organizations choose noncooperative strategy, and \bar{U}_2 represents the average expected return of social organizations. According to the above analysis, there are

$$\begin{aligned} U_{21} &= xz(W_1 - W_2 + W_3 - S_4) + x(1 - z)(W_1 - W_2 + W_3 - k_2 A_2) + (1 - x)z(W_1 - W_2 - S_4) + (1 - x) \\ &\cdot (1 - z)(W_1 - W_2 - k_2 A_2), \\ U_{12} &= xz(-k_1 A_1) + x(1 - z)(-k_1 A_1 - k_2 A_2) + (1 - x)z(-k_1 A_1) + (1 - x)(1 - z)(-k_1 A_1 - k_2 A_2), \\ \bar{U}_2 &= yU_{21} + (1 - y)U_{22} = yxz(W_1 - W_2 + W_3 - S_4) + yx(1 - z)(W_1 - W_2 + W_3 - k_2 A_2) \\ &+ y(1 - x)z(W_1 - W_2 - S_4) + y(1 - x)(1 - z)(W_1 - W_2 - k_2 A_2) + (1 - y)xz(-k_1 A_1) \\ &+ (1 - y)x(1 - z)(-k_1 A_1 - k_2 A_2) + (1 - y)(1 - x)z(-k_1 A_1) + (1 - y)(1 - x)(1 - z)(-k_1 A_1 - k_2 A_2). \end{aligned} \quad (4)$$

Suppose that U_{31} represents the expected return when the poverty group chooses the cooperative strategy, U_{32} represents the expected return when the poverty group

chooses the noncooperative strategy, and \bar{U}_3 represents the average expected return of the average poor group. According to the above analysis, there are

$$\begin{aligned}
 U_{32} &= xy[-(1-k_2)A_2] + x(1-y)[-(1-k_1)A_1 - (1-k_2)A_2] + (1-x)y[-(1-k_2)A_2] + (1-x)(1-y) \\
 &\quad \cdot [-(1-k_1)A_1 - (1-k_2)A_2], \\
 U_{31} &= xy(S_1 - S_2 + S_3 + S_4) + x(1-y)[S_1 - S_2 + S_3 - (1-k_1)A_1] \\
 &\quad + (1-x)y(S_1 - S_2 + S_4) + (1-x)(1-y)[S_1 - S_2 - (1-k_1)A_1], \\
 \bar{U}_3 &= zU_{31} + (1-z)U_{32} = zxy(S_1 - S_2 + S_3 + S_4) + zx(1-y)[S_1 - S_2 + S_3 - (1-k_1)A_1] \\
 &\quad + z(1-x)y(S_1 - S_2 + S_4) + z(1-x)(1-y)[S_1 - S_2 - (1-k_1)A_1] + (1-z)xy[-(1-k_2)A_2] \\
 &\quad + (1-z)x(1-y)[-(1-k_1)A_1 - (1-k_2)A_2] + (1-z)(1-x)y[-(1-k_2)A_2] \\
 &\quad + (1-z)(1-x)(1-y)[-(1-k_1)A_1 - (1-k_2)A_2].
 \end{aligned} \tag{5}$$

4.2. Dynamic Replication Equation for a Three-Party Game. According to the Malthusian equation, the dynamic replication equation for the local government to choose cooperative strategy is as follows:

$$\begin{aligned}
 F_1(x) &= \frac{dx}{dt} \\
 &= x(U_{11} - \bar{U}_1) \\
 &= x(1-x)(U_{11} - U_{12}) \\
 &= x(1-x)[C_1 - C_2 - yW_3 - zS_3 + yzC_3].
 \end{aligned} \tag{6}$$

The dynamic replication equation for social organization to choose cooperative strategy is as follows:

$$\begin{aligned}
 F_2(y) &= \frac{dy}{dt} \\
 &= y(U_{21} - \bar{U}_2) \\
 &= y(1-y)(U_{21} - U_{22}) \\
 &= y(1-y)[xW_3 - zS_4 + W_1 - W_2 + k_1A_1].
 \end{aligned} \tag{7}$$

The dynamic replication equation for cooperative strategy among the poverty groups is as follows:

$$\begin{aligned}
 F_3(z) &= \frac{dz}{dt} \\
 &= z(U_{31} - \bar{U}_3) \\
 &= z(1-z)(U_{31} - U_{32}) \\
 &= z(1-z)[xS_3 + yS_4 + S_1 - S_2 + (1-k_2)A_2].
 \end{aligned} \tag{8}$$

The following three-dimensional dynamic system (I) can be obtained from the replicated dynamic equations of local governments, social organizations, and poverty groups:

$$\begin{cases} F_1(x) = x(1-x)[C_1 - C_2 - yW_3 - zS_3 + yzC_3], \\ F_2(y) = y(1-y)[xW_3 - zS_4 + W_1 - W_2 + k_1A_1], \\ F_3(z) = z(1-z)[xS_3 + yS_4 + S_1 - S_2 + (1-k_2)A_2]. \end{cases} \tag{9}$$

Theorem 1. *The three-dimensional dynamic system (I) mentioned above must have $2^3 = 8$ pure strategic equilibrium points, which are, respectively, $(1, 1, 1)$, $(1, 1, 0)$, $(1, 0, 1)$, $(1, 0, 0)$, $(0, 1, 1)$, $(0, 1, 0)$, $(0, 0, 1)$, and $(0, 0, 0)$. Meanwhile, there are six possible equilibrium points for a single pure strategy, namely, $(0, ((S_2 - S_1 - (1-k_2)A_2)/S_4), ((W_1 - W_2 + k_1A_1)/S_4))$, $(((-S_1 + S_2 - (1-k_2)A_2)/S_3), 0, ((C_1 - C_2)/S_3))$, $(((-W_1 + W_2 - k_1A_1)/W_3), ((C_1 - C_2)/W_3), 0)$, $(1, ((-S_3 - S_1 + S_2 - (1-k_2)A_2)/S_4), ((W_3 + W_1 - W_2 + k_1A_1)/S_4))$, $(((-S_4 - S_1 + S_2 - (1-k_2)A_2)/S_3), 1, ((C_1 - C_2 - W_3)/(S_3 - C_3)))$, and $((S_4 - W_1 + W_2 - k_1A_1)/W_3), ((C_1 - C_2 - S_3)/(W_3 - C_3)), 1)$. The first equilibrium point exists if $0 < ((S_2 - S_1 - (1-k_2)A_2)/S_4) < 1$ and $0 < ((W_1 - W_2 + k_1A_1)/S_4) < 1$. The conditions for the existence of other equilibrium points can be obtained.*

Proof. For the three-dimensional dynamic system, if $x = 0$ or $x = 1$, $y = 0$ or $y = 1$, and $z = 0$ or $z = 1$, there will be $F_1(x) = 0$, $F_2(y) = 0$, and $F_3(z) = 0$. Therefore, $(1, 1, 1)$, $(1, 1, 0)$, $(1, 0, 1)$, $(1, 0, 0)$, $(0, 1, 1)$, $(0, 1, 0)$, $(0, 0, 1)$, and $(0, 0, 0)$ are the equilibrium points for the system. If $x = 0$, $0 < y < 1$, and $0 < z < 1$, when $-zS_4 + W_1 - W_2 + k_1A_1 = 0$ and $yS_4 + S_1 - S_2 + (1-k_2)A_2 = 0$, then there is $F_1(x) = 0$, $F_2(y) = 0$, and $F_3(z) = 0$. Therefore, if $0 < ((S_2 - S_1 - (1-k_2)A_2)/S_4) < 1$ and $0 < ((W_1 - W_2 + k_1A_1)/S_4) < 1$, then $(0, ((S_2 - S_1 - (1-k_2)A_2)/S_4), ((W_1 - W_2 + k_1A_1)/S_4))$ is the equilibrium point of the three-dimensional dynamical system. Similarly, the equilibrium points of the other 5 single pure strategies can be proved. \square

Theorem 2. *There may be one equilibrium point (x^*, y^*, z^*) of hybrid strategy in a three-dimensional dynamic system (I), which satisfies $(x^*, y^*, z^*) \in (0, 1)$.*

Proof. For a three-dimensional dynamic system (I), if $0 < x < 1$, $0 < y < 1$, and $0 < z < 1$, when $C_1 - C_2 - yW_3 - zS_3 + yzC_3 = 0$, $xW_3 - zS_4 + W_1 - W_2 + k_1A_1 = 0$, and $xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 = 0$, then there is $F_1(x) = 0$, $F_2(y) = 0$, and $F_3(z) = 0$. Solve equation (1) and (x^*, y^*, z^*) can be obtained, which is the possible equilibrium point of the three-dimensional dynamic system (I):

$$\begin{cases} C_1 - C_2 - yW_3 - zS_3 + yzC_3 = 0, \\ xW_3 - zS_4 + W_1 - W_2 + k_1A_1 = 0, \\ xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 = 0. \end{cases} \quad (10)$$

□

4.3. Stability Analysis of Evolutionary Game. According to the above analysis, the financial support of the superior government, the negative return caused by noncooperation, and the difference between their own benefits and costs are the key factors influencing the game behaviour choice of the three parties.

In order to analyze the asymptotic stability of the tripartite main body, take the derivative of each replicate dynamic equation of the three-dimensional dynamic system (I), then

$$\begin{cases} F_1'(x) = (1 - 2x)[C_1 - C_2 - yW_3 - zS_3 + yzC_3], \\ F_2'(y) = (1 - 2y)[xW_3 - zS_4 + W_1 - W_2 + k_1A_1], \\ F_3'(z) = (1 - 2z)[xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2]. \end{cases} \quad (11)$$

According to the basic nature of the evolutionary game, (x^*, y^*, z^*) is substituted in formula (2). When $F_1'(x) < 0$, $F_2'(y) < 0$, $F_3'(z) < 0$, (x^*, y^*, z^*) are the stable strategies that should be adopted by local governments, social organizations, and poverty groups. The following is an analysis of the asymptotic stability of the three-party game players.

- (1) Analysis on the gradual stability of local governments:

If $C_1 - C_2 - yW_3 - zS_3 + yzC_3 = 0$, then there is $F_1(x) \equiv 0$. That is to say, the local government's strategic choices are stable, that is, the proportion of local government's strategic choices will not change with the time passing by.

If $C_1 - C_2 - yW_3 - zS_3 + yzC_3 > 0$, let $F_1(x) = 0$, and $x = 0$ and $x = 1$ are the two stable points for x . It can be obtained from equation (2) that the derivative of $F_1(x)$ is $F_1'(x) = (1 - 2x)[C_1 - C_2 - yW_3 - zS_3 + yzC_3]$. There is $F_1'(0) > 0$, $F_1'(1) < 0$. Therefore, $x = 1$ is the equilibrium points of the strategies of local governments. This means that the support provided by the superior government and the external benefits of local governments C_1 and C_3 , when the three main bodies are active in poverty alleviation, the support of local governments to social

organizations and poverty groups S_3 and W_3 , and the costs that local governments need to pay in the process of targeted poverty alleviation C_2 are important factors influencing the strategic choice of local governments. The support of local governments for social organizations and poor groups S_3 and W_3 is the focus that local governments should consider. At this time, the support for social organizations and poverty groups may be rewarded in various ways through poverty alleviation, but at this time, local governments only consider the loss of interest in the game process. Obviously, the local government is always cautious in the process of strategy selection. If the local government believes that the support for social organizations and poverty groups is beyond its means, it will prompt the local government to choose the noncooperative strategy.

Similarly, if $C_1 - C_2 - yW_3 - zS_3 + yzC_3 < 0$, then $F_1'(0) < 0$ and $F_1'(1) > 0$, so $x = 0$ is the equilibrium points of the local government strategy. This shows that the income gained by the local governments to choose cooperation when the higher-level government support and incentives less than the extra-income of noncooperative strategy. That is to say, at this time, the support and externality benefit from the government at a higher level are not enough to make up for its poverty alleviation costs (costs, support for the organization, and society), the noncooperative strategy is the evolutionary stable strategy of the local government.

- (2) Analysis of the progressive stability of social organizations:

If $xW_3 - zS_4 + W_1 - W_2 + k_1A_1 = 0$, then there is $F_2(y) \equiv 0$, that is to say, the social organization's strategic choice is at a stable state, that is, the proportion of social organization's strategic choice will not change with the time going by.

If $xW_3 - zS_4 + W_1 - W_2 + k_1A_1 > 0$, let $F_2(y) = 0$, then $y = 0$ and $y = 1$ are two stable points. At this point, it can be seen from equation (2) that the derivative of $F_2(y)$ is $F_2'(y) = (1 - 2y)[xW_3 - zS_4 + W_1 - W_2 + k_1A_1]$ and $F_2'(0) > 0$ and $F_2'(1) < 0$. Therefore, $y = 1$ is the equilibrium point of social organization strategy. This shows that the local government's support for social organizations W_3 , the basic benefits W_1 gained by social organizations when they choose to help the poverty, the support of social organizations S_4 when they choose to cooperate with poor groups and the cost of poverty alleviation W_2 , and the loss of opportunity cost k_1A_1 when they do not cooperate in poverty alleviation are very important factors influencing the strategic choice of social organizations. In fact, in the process of targeted poverty alleviation, the cost of poverty alleviation paid by social organizations is not high, while once the poor groups get rid of poverty, the benefits of social organizations are various.

Therefore, it is worth paying attention to the establishment of an appropriate antipoverty incentive mechanism for social organizations.

Similarly, if $xW_3 - zS_4 + W_1 - W_2 + k_1A_1 < 0$, then $F'_2(0) < 0$ and $F'_2(1) > 0$, so $y = 0$ is the balance point of social organization strategy. This shows that the income gained by the social organization choose cooperation (local government support, their basic income, poverty alleviation, and no cooperation opportunity cost) is less than noncooperative extraincome. That is to say, at this point, the local government for their support and their basic income is insufficient to make up for its poverty alleviation costs (costs support for poverty), and the noncooperative strategy is the evolutionary stable strategy of local government.

(3) Analysis of the gradual stability of poverty groups:

If $xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 = 0$, then there is $F_3(z) \equiv 0$. That is to say, the poverty group's strategic choice is in a stable state, that is, the proportion of the poverty group's strategic choice will not change with the passage of time.

If $xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 > 0$, let $F_3(z) = 0$, then $z = 0$ and $z = 1$ are the two stable points of z . At this point, the derivative of $F_3(z)$ from equation (2) is $F'_3(z) = (1 - 2z)[xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2]$. There is $F'_3(0) > 0$ and $F'_3(1) < 0$. Therefore, $z = 1$ is the equilibrium point of the strategy of the poverty group. This shows that the support of local governments and social organizations for poverty groups S_3 and S_4 , the basic benefits S_1 gained by poor groups when they choose to help the poor, the cost of poverty alleviation S_2 , and the loss of opportunity cost $(1 - k_2)A_2$ when they do not cooperate in poverty alleviation are important factors influencing the strategic choice of poverty groups. Poverty groups play a very important role in the process of poverty alleviation, and the basic income and the impact of strategy selection are inseparable with local government and social organizations. Therefore, the basic income of the poverty group, local government, and social organizations play an important role in the targeted poverty alleviation.

Similarly, if $xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 < 0$, then $F'_3(0) < 0$ and $F'_3(1) > 0$, so $z = 0$ is the equilibrium point of the strategy of the poverty group. It shows that the income gained by the poverty choosing cooperative strategy (the support of local government and social organizations, their basic income from poverty alleviation, and opportunity cost from noncooperative strategy) is less than the extra income from noncooperative strategy. When the local government and social organizations for their support and their basic income are not enough to make up for its poverty alleviation costs (costs), the cooperation strategy is poor at this time from the evolutionary stable strategy.

Combined the initial states and strategy choices if local government and poverty, when $C_1 - C_2 - yW_3 - zS_3 + yzC_3 > 0$, $xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 < 0$, while the support from the local government is more important to both local government and the poverty groups, as long as the local government can help reduce costs for poverty alleviation poverty group, at the same time increase the opportunity cost the poverty groups choose noncooperative strategy, and it will promote the cooperative strategy selection of local governments and poverty groups. As a matter of fact, the financial support from local governments can play a role for poverty alleviation in a certain stage, and it is not a long-term solution. Local governments should be committed to helping poor groups reduce the cost of poverty alleviation and, at the same time, build incentive mechanisms including policies to continue to enjoy the benefits after "lifting off the poverty cap".

Combining the initial states with strategic choices of social organizations and poverty groups, when $xW_3 - zS_4 + W_1 - W_2 + k_1A_1 > 0$, $xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 > 0$, the opportunity cost of the targeted antipoverty noncooperative strategy has a great impact on the strategic choice of both sides. Therefore, targeted poverty alleviation cooperation between social organizations and poverty groups can reduce the loss of opportunity cost. Meanwhile, the support of local governments is also the key to the realization of targeted poverty alleviation cooperation between social organizations and poor groups. Therefore, it is urgent to establish a precise cooperation mechanism for poverty alleviation with local government as the leading role, social organizations as the guide, and poor groups as the main body.

5. Numerical Simulation and Simulation

Relevant parameters were set through the research group's statistical data of the questionnaire survey for the third-party assessment of targeted poverty alleviation in Xinjiang in 2018. Xinjiang is a contiguous poverty-stricken region designated by the state, and the four prefectures in southern Xinjiang are among the three regions and three prefectures designated by the state for poverty alleviation.

At present, there are 588.7 thousand households, 2.3147 million poverty people, 2,131 poverty villages, and 13 counties broken away from poverty at the end of 2018, which has decreased the poverty household to 204.4 thousand, the poverty population to 817.1 thousand, the poverty villages to 1,537, and the poverty counties to 22. In this paper, taking a county as an example, the calculation results of various parameters are as shown in Table 5.

- (1) The influence of initial willingness to cooperate on the evolutionary path of multiagent collaborative governance:

According to the above analysis, the initial willingness of multiagent cooperation will influence the final evolution path. Through the simulation of survey data, it can be found that, for a fixed value x , no matter what the value of y and z is, there are always duplicating dynamic equations of social

TABLE 5: Related data statistics in X country, Xinjiang (ten thousand RMB).

Parameters	Implications	Value
C_1	The support provided by the superior government when the local government is active in poverty alleviation	1,200
C_2	The cost local governments need to pay in the process of targeted poverty alleviation	560
C_3	The external benefits brought by local governments due to poverty alleviation when the three parties are active in poverty alleviation	890
C_4	The loss of opportunity costs when local governments are active in poverty alleviation but other players do not cooperate	650
W_1	The basic benefits of targeted poverty alleviation when social organizations choose cooperative strategies	100
W_2	The cost of cooperation among social organizations in the process of targeted poverty alleviation	450
W_3	The support given by local governments to social organizations in choosing cooperative strategies	300
$k_1 A_1$	Negative returns caused by social organizations to choose the strategy of noncooperative strategy	20
S_1	The basic benefits of targeted poverty alleviation when poverty groups choose cooperative strategies	200
S_2	The cost of cooperation among poverty groups in the process of targeted poverty alleviation	1100
S_3	The support given by local governments to poverty groups in choosing cooperative strategies	400
S_4	The support given by social organizations to poverty groups in choosing cooperative strategies	300
$(1 - k_2)A_2$	The negative return caused by the poverty group chooses not to cooperate the strategy	200

Data source: the third party assessment questionnaire data statistics in Xinjiang targeted poverty alleviation in 2018.

organizations and poverty groups $xW_3 - zS_4 + W_1 - W_2 + k_1 A_1 < 0$, and $xS_3 + yS_4 + S_1 - S_2 + (1 - k_2)A_2 < 0$. That is to say, only the cooperative willingness of local governments will have an impact on the final evolution path. According to the survey, there are about 50% social organizations and poverty groups are willing to cooperate, that is, $y = 0.5$ and $z = 0.5$. The influence of the evolution result of multiagent collaborative governance and initial willingness to cooperate on a single subject is shown in Figures 2 and 3.

As can be seen from Figure 2, if the initial cooperative intention of local governments x is taken at any value, the evolution result of multiagent collaborative governance is $(1, 0, 0)$. That is, the government actively participates, social organizations do not participate, and the poor population actively participate in poverty alleviation. Obviously, this is not enough to achieve China's 2020 goal of poverty alleviation. As can be seen in Figure 3, the impact on a single subject does not change much, nor does the final cooperation strategy change.

Set $y = 0.5$ and $z = 0.5$, the value of x will change as follows. (1) The evolution curve of the value x finally gets to 1, which indicates that the change of the value of x shows a monotonic rising trend, the rising speed gradually weakens as time goes on, and the end point of the final evolution is the active cooperation of local governments. This shows that, in the process of multisubject collaborative governance for targeted poverty alleviation, various national and local policies can ensure that local governments always take the completion of targeted poverty alleviation tasks as the basic goal. (2) The evolution curve of the value y finally gets to 0, which indicates that the change of value of y shows a monotony downward trend, and the decline rate gradually weakens with the passage of time. The end point of the final evolution is that social organizations do not participate in poverty alleviation. This shows the initial local government

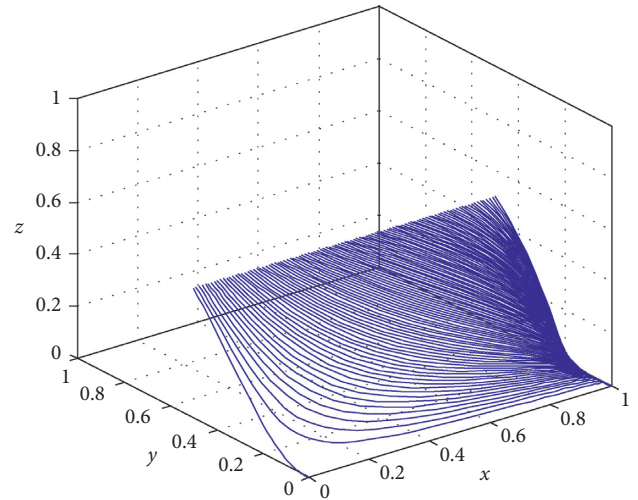


FIGURE 2: The influence of local governments' initial cooperative willingness on the evolutionary path when $y = 0.5$ and $z = 0.5$.

policies do not affect social organizations in poverty alleviation. Because of its own interests, it was not involved in poverty reduction motives. Of course, once the government extends enough support to the social organizations for poverty alleviation in rewards and punishment mechanism, it will take the initiative to choose to participate in poverty alleviation. The evolution curve of the value is obtained, which finally evolves to 0, indicating that the change of the value presents a monotony downward trend, and the decline rate gradually weakens with the passage of time, and the end point of the final evolution is the negative cooperation of the poor population. (3) The evolution curve of the value z finally gets to 0, which indicates that there is a monotonic decline in the value z , and the rate of decline tapered off over time. The end point of evolution is the passive cooperation of poverty. Therefore, at present, the targeted multisubject

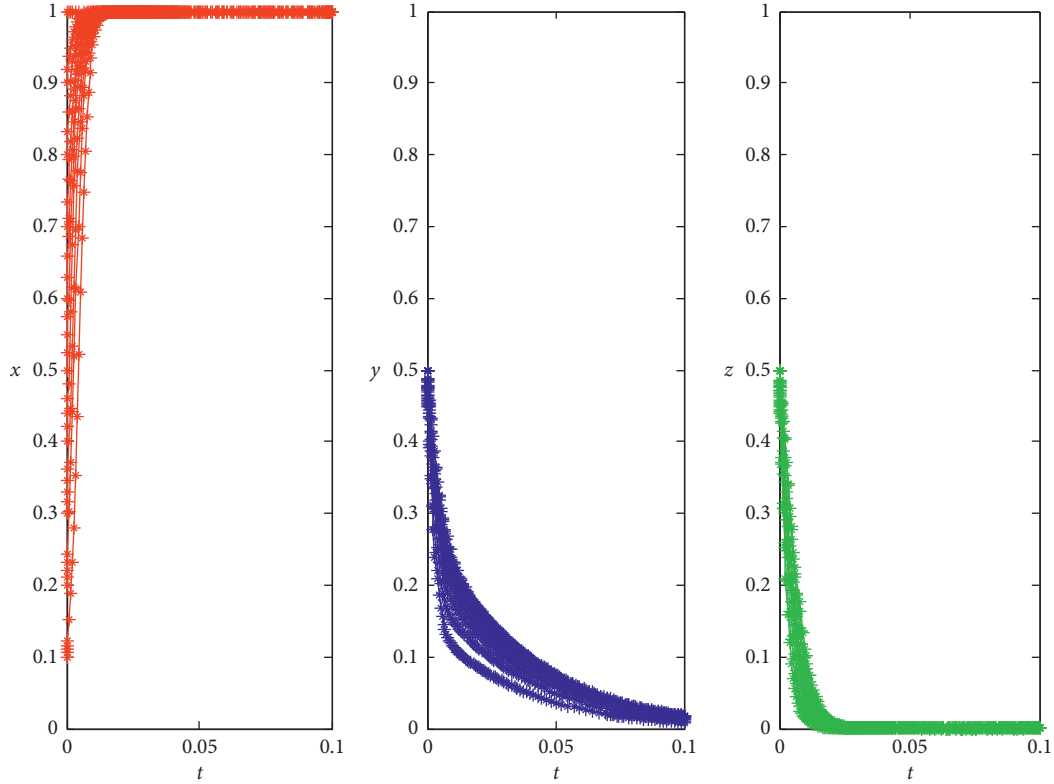


FIGURE 3: The influence of local government's initial cooperative willingness on the single subjects if $y = 0.5$ and $z = 0.5$.

collaborative governance for poverty alleviation in a county in Xinjiang is not in the Pareto optimal state, and more powerful measures and policies are needed to promote the realization of the goal of multisubject collaborative governance.

- (2) Whether increasing support for each participant will affect the evolution of tripartite competition:

According to the relevant theoretical analysis, the support strength of each participant will have an impact on the dynamic replication equation of the evolutionary game, thus affecting the final evolutionary equilibrium result. This part is taken $x = 0.5$, $y = 0.5$, and $z = 0.5$ as the initial cooperative intention to study the influence of improving C_1 , S_3 , S_4 , and W_3 on the final evolution result, as shown in Figures 4–9.

As can be seen from Figures 4 and 5, improving the support provided by the higher level government for the local government's active poverty alleviation C_1 will not promote tripartite cooperation. This conclusion is not consistent with the general cognition. For local governments, the support from the superior government will be the main benefit due to the consideration of their own costs and risks, but social organizations and poor groups are not sensitive to the support from the superior government.

With the increase of C_1 , the efficiency of the active cooperation of local government is improved, but the cooperative behaviour of social organizations and

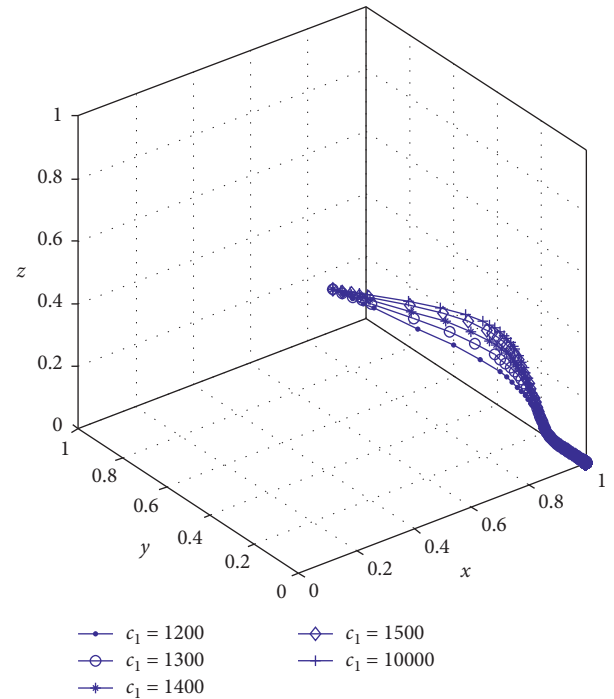


FIGURE 4: The influence of increasing C_1 on the evolution path of multiagent collaborative governance when $x = 0.5$, $y = 0.5$, and $z = 0.5$.

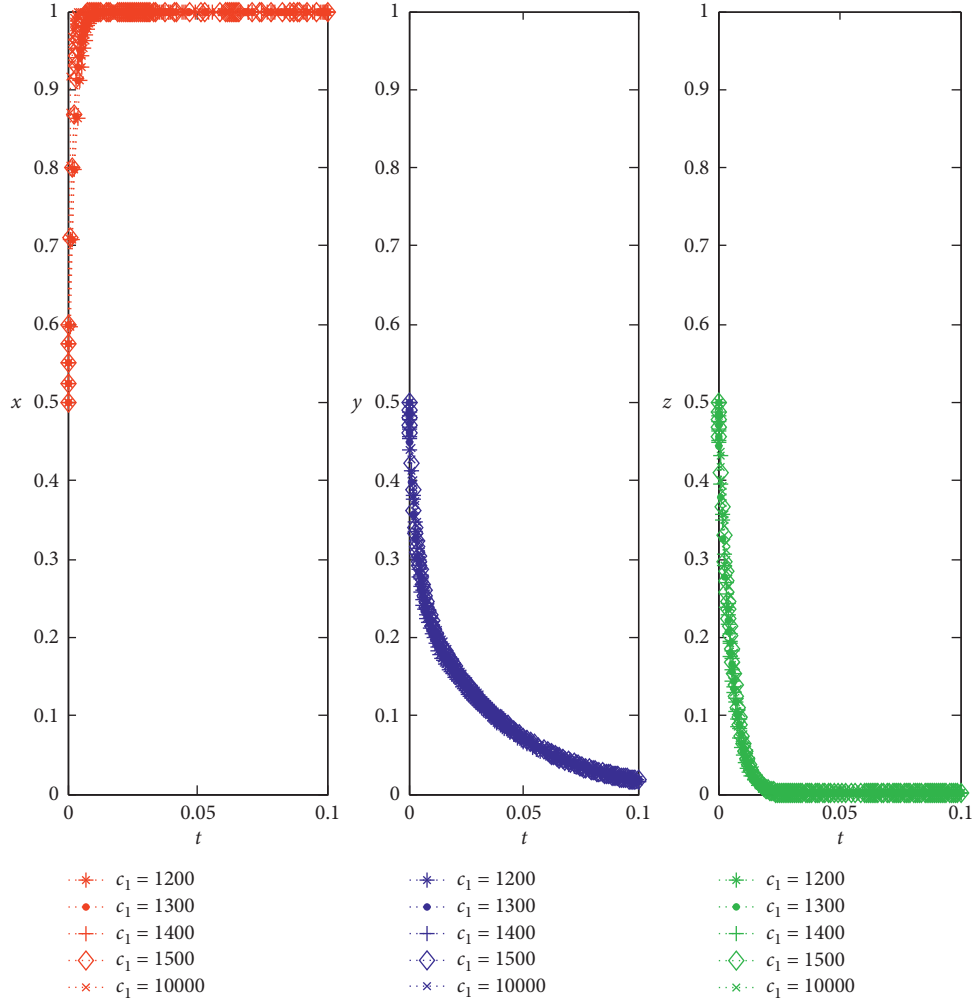


FIGURE 5: The influence of increasing C_1 on the evolution path of single agent when $x = 0.5$, $y = 0.5$, and $z = 0.5$.

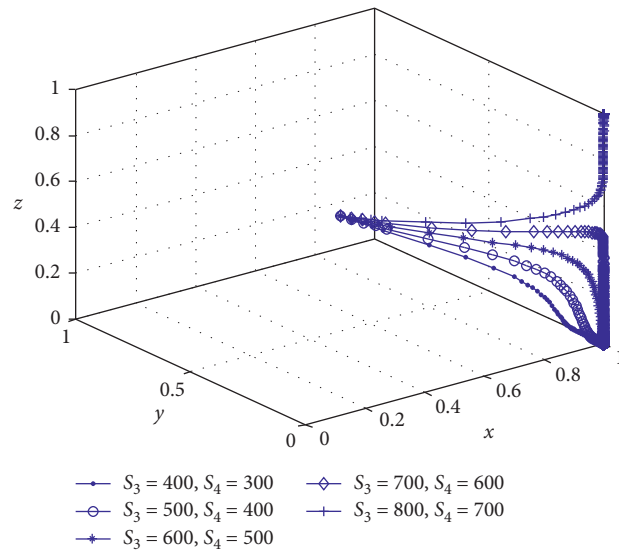


FIGURE 6: The influence of increasing S_3 and S_4 on the evolution path of multiagent collaborative governance when $x = 0.5$, $y = 0.5$, and $z = 0.5$.

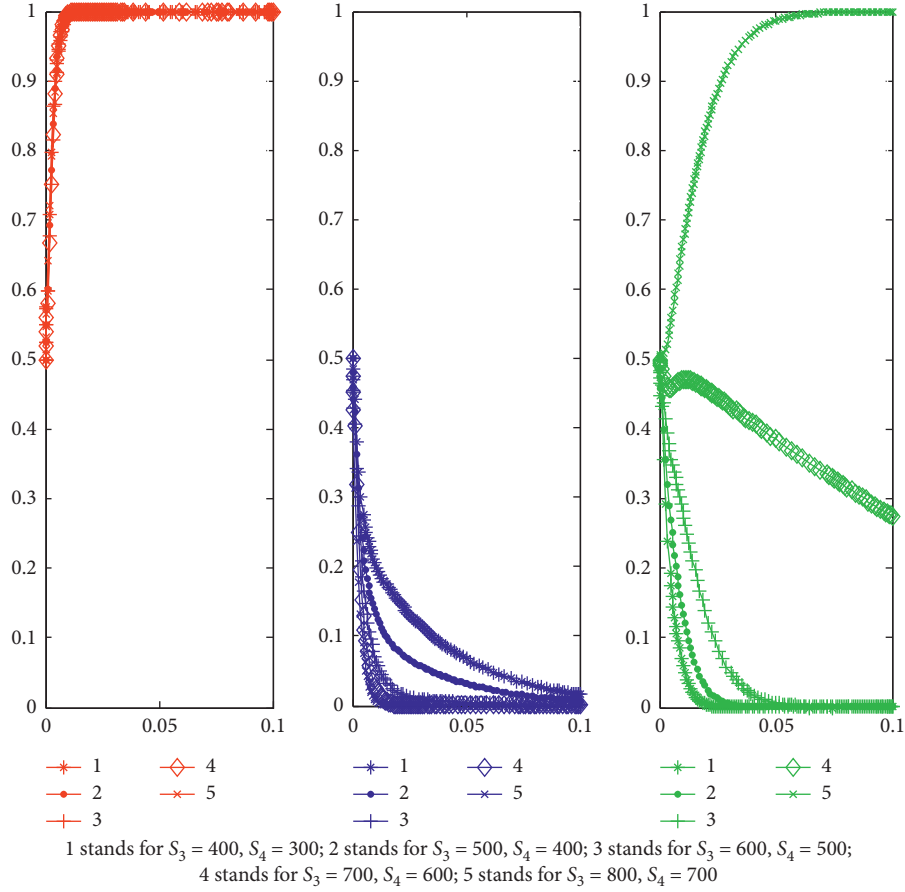


FIGURE 7: The influence of increasing S_3 and S_4 on the single agent when $x = 0.5, y = 0.5$, and $z = 0.5$.

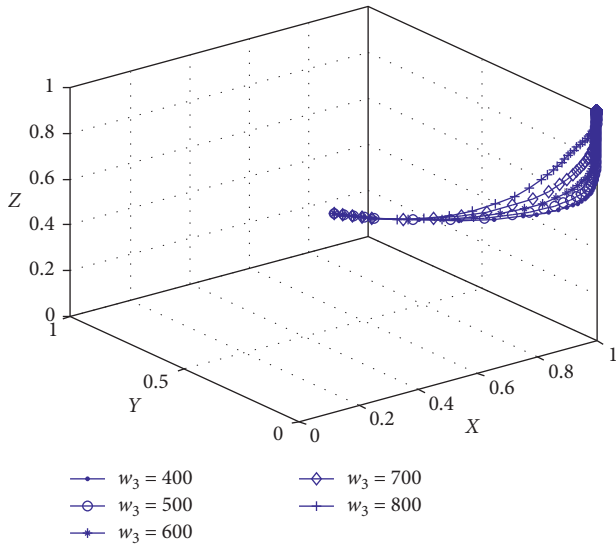


FIGURE 8: The influence of increasing W_3 on the evolution path of multi-agent collaborative governance when $x = 0.5, y = 0.5$, and $z = 0.5$.

poverty groups is not promoted, due to the fact that the subsidies from the superior government do not encourage and stimulate endogenous impetus of

poverty groups. Therefore, in the process of targeted poverty alleviation, the role of the government should be transformed to avoid the disadvantages of top-down one-way poverty alleviation and build a poverty alleviation framework with the participation of multiple subjects.

It can be seen from Figures 6 and 7 that the improvement of local government's support for the poverty groups S_3 and social organizations' support for the poverty groups S_4 will promote the positive cooperation of the poverty groups. This is consistent with the results of the literature [61, 62, 64]. Compared with the evolution path in Figure 3, the evolution path of the local government does not change a lot, but due to paying a certain cost, the evolution velocity of social organization to zero steady-state increases with the increase of its support from the poverty group. When the support from the local government and social organizations increases, the benefits obtained by the poverty groups will increase. At the same time, the increase of local governments and social organizations' support for poverty groups makes the poverty alleviation drive of the poverty groups appear. When the support reaches a certain level, the poverty groups turn from

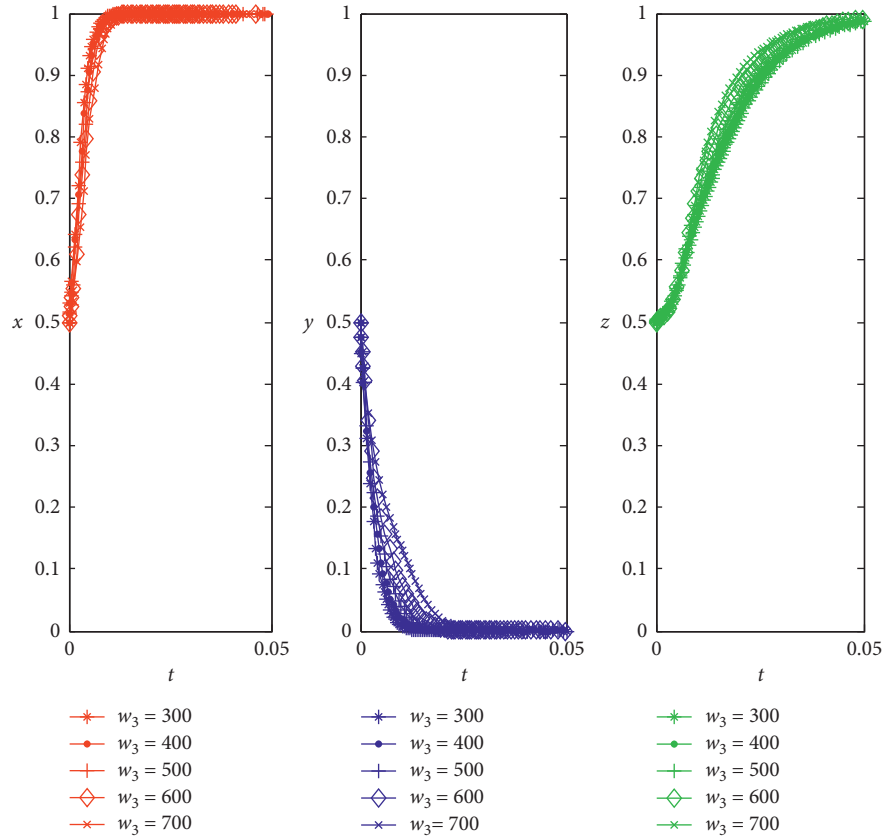


FIGURE 9: The influence of increasing W_3 on the single agent when $x = 0.5$, $y = 0.5$, and $z = 0.5$.

passive poverty alleviation strategies to active poverty alleviation. Therefore, it can be believed that the enhancement of support from local governments and social organizations can effectively promote the conversion of cooperation willingness of the poor groups, such as providing jobs, increasing relevant subsidies, and providing technical service guidance, which are all positive incentive measures for the poverty groups.

It can be seen from Figures 8 and 9 that when improving the local government support for social organizations W_3 , social organizations do not choose cooperative strategy. The main reason is that, on the one hand, social organizations exert certain subsidies to the poverty group; on the other hand, the local government gives insufficient support to social organizations. Therefore, the support of governments towards social organizations should be improved. Relevant data found that the financial support of foreign governments to social organizations is strong. It can be said that governments are still the main source of funds for the survival and development of social organizations. For example, according to professor Salamon's research, the financial support of the US government to social organizations was as high as 30.5% in 1995, making it the second largest source of funds for social organizations after service charges. Services and fees accounted for 44%

of the revenues of social organizations in the UK in 1995, donations for 9%, and government grants for 47%. Moreover, in the 10 years from 1991 to 2001, the income of social organizations increased by 40% from the government, while the overall income of social organizations increased by 32%. Among the developed countries in Europe, the Netherlands is also a typical country that relies on government financial support for the operation of social organizations. The Netherlands has a huge social organization, spending 15% of GDP; Employment accounts for 12.6 per cent of the country's nonagricultural workforce, yet only 39% of its total income comes from service fees, 10% from charitable donations and as much as 59% from government financial support. Although there are no valid statistics in Singapore, the government's support for social organizations has been recognized by the society under the model of government-led construction of social organizations. Therefore, in the process of multisubject-targeted poverty alleviation collaborative governance in China, the government also needs to increase its support for social organizations.

- (3) Whether increasing the negative income of social organizations and poverty groups will affect the evolution of tripartite competition:

Social organizations and poverty groups adopt strategies (nonparticipation and negative) and

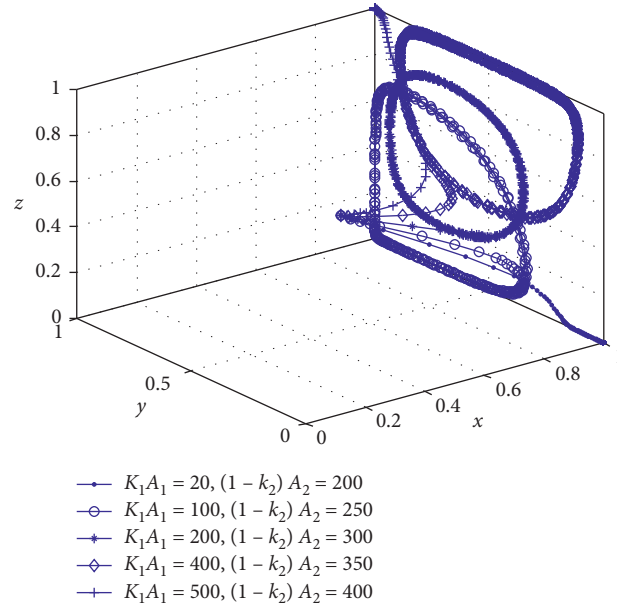


FIGURE 10: The influence of improving k_1A_1 and $(1 - k_2)A_2$ on the evolution path of multiagent collaborative governance when $x = 0.5$, $y = 0.5$, and $z = 0.5$.

negative earnings K_1A_1 , $(1 - K_1)A_1$, K_2A_2 , and $(1 - K_2)A_2$ will be produced. If they found noncooperative strategy does harm to their own interests, they will eventually choose the cooperative strategy with the increase of loss. Therefore, to some extent, the increase of negative earnings will promote the behaviour positive cooperation. This part is still taken $x = 0.5$, $y = 0.5$, and $z = 0.5$ as the initial cooperative intention to study the influence of improvement on the final evolution result, as shown in Figures 10 and 11.

It can be seen from Figures 10 and 11 that, with the increase of negative returns of social organizations and groups, the evolution path of the local government did not have the too big change, while social organizations tend to take cooperative strategies. In the initial stage of evolution, social organizations are not involved in poverty alleviation. With the increase of evolution and negative returns, social organizations will choose to participate in poverty alleviation. As for the poverty groups, inactive participation in poverty alleviation will lead to environment worsening and resources shortage so that the poverty groups will become much poorer. Therefore, negative poverty alleviation has a significant impact on the benefits gained by the poverty group. Once the negative earnings or opportunity cost of negative poverty alleviation reaches a certain threshold, the poverty groups will choose the positive strategy from consideration of self-interest optimal. Therefore, the negative income of social organizations and poverty groups plays a positive role in the multisubject collaborative governance of targeted poverty alleviation.

- (4) Whether increasing the basic economic benefits of social organizations and poverty groups will affect the evolution of tripartite competition and cooperation:

According to relevant theoretical analysis, in the case of local government incentives, the increase of basic economic benefits W_1 and income of social organizations and poverty groups S_1 will affect the replication of the dynamic equation, thus influencing the final evolutionary equilibrium result. The related research also shows the correctness of this paper [65, 66]. This part still takes $x = 0.5$, $y = 0.5$, and $z = 0.5$ as the initial cooperative intention to study the influence of improving W_1 and S_1 on the final evolution results, as shown in Figures 12 and 13. It can be seen from Figure 12 that the increase of basic economic benefits W_1 and income of social organizations and poverty groups S_1 will affect the evolutionary equilibrium result, from $(1, 0, 0) \rightarrow (1, 0, 1) \rightarrow (1, 1, 1)$. As can be seen from Figure 13, with the increase of W_1 and S_1 , the evolution result of local governments has not changed significantly because local governments have been in a state of stimulating poverty alleviation through policies. At this point, social organizations can obtain more benefits due to the increase of basic benefits W_1 . However, when the benefits are within a certain range, the strategic selection of social organizations is always in a state of fluctuation and does not reach the equilibrium point. When W_1 reaches about 500, the strategic choice of social organizations no longer fluctuates, but finally approaches 1. For the poverty group, the speed of reaching the equilibrium state is much

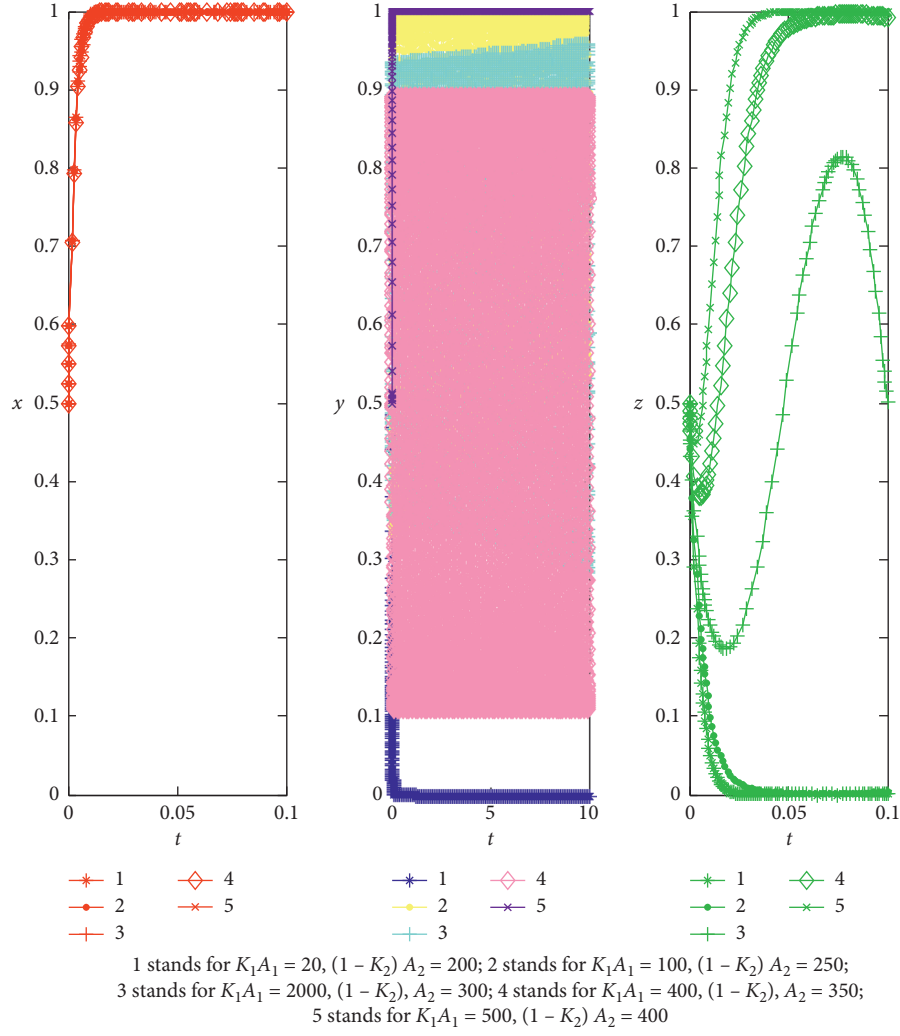


FIGURE 11: The influence of improving k_1A_1 and $(1 - k_2)A_2$ on the evolution path of single agent when $x = 0.5, y = 0.5$, and $z = 0.5$.

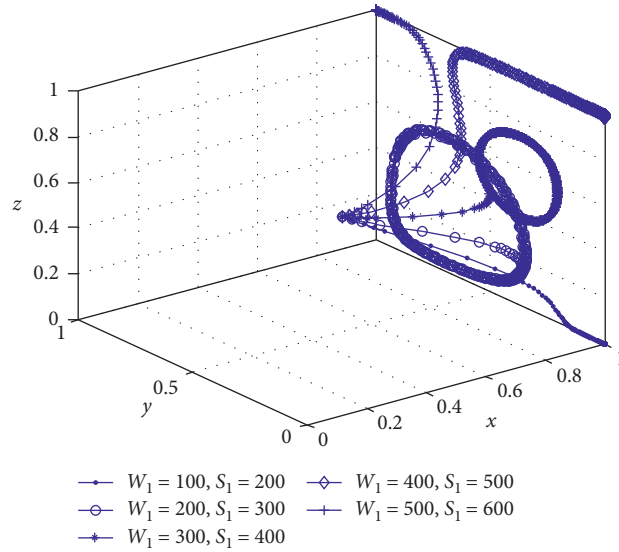


FIGURE 12: The influence of increasing W_1 and S_1 on the evolution path of multiagent collaborative governance when $x = 0.5, y = 0.5$, and $z = 0.5$.

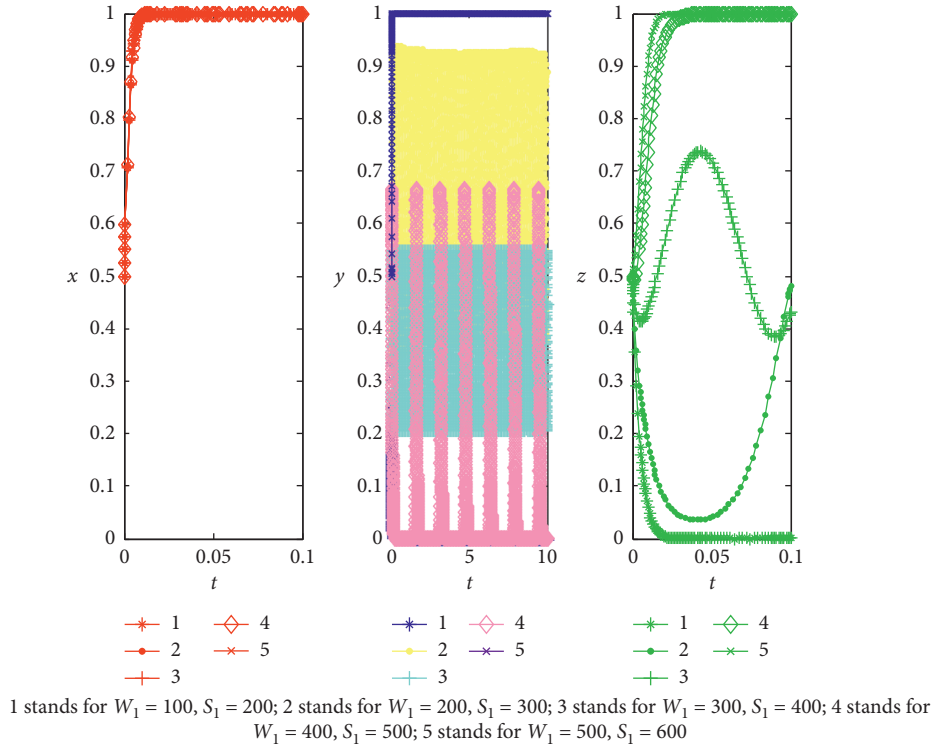


FIGURE 13: The influence of increasing W_1 and S_1 on single agent when $x = 0.5$, $y = 0.5$, and $z = 0.5$.

higher than that of social organizations because, for the poverty group, the improvement of its income will greatly stimulate the long-term economic and social effects. At the same time, under the guidance of external policies and targeted poverty alleviation policies, it will spare no effort to achieve the goal of poverty alleviation. Therefore, the increasing the basic economic benefits of both sides can eliminate regional poverty and gradually realize the goal of comprehensive poverty alleviation.

6. Conclusion

Precise poverty alleviation work is a wide-ranging, huge-investment, and complex-situation system engineering, with dynamic, multidimensional, relativity, and diversity characteristics, involving many relevant interest groups [61–66]. Under the condition of limited rationality, this paper studies the evolutionary game model of multiagent collaborative governance of local governments, social organizations, and poor groups in the process of targeted poverty alleviation. Through the analysis of evolutionary stability strategies, we obtain the support of social organizations and local governments, the cooperative benefits of social organizations and poor groups, and the negative benefits of noncooperation between social organizations and poor groups are the key factors that affect the cooperation of tripartite evolutionary games. Different from the existing related research, this paper uses the survey data and the actual interview data to make a dynamic evolution analysis on the strategy choice of local government, social organizations, and the poor

groups and simulates the path of different stakeholders to form the interest balance in the real situation. The main contribution of this article is to be able to choose model setting and simulate realistic effects from a multiagent collaborative governance equilibrium strategy more practically and fully demonstrate the actual situation of poverty alleviation work in a county in Xinjiang.

The main conclusions are as follows:

- (1) Increasing the support of social organizations and local governments will affect the evolution of tripartite competition, but the support should be appropriate, too much blood transfusion-type support from the higher government cannot promote poverty alleviation groups to maintain the active poverty alleviation state and poverty groups to maintain active poverty alleviation state. Therefore, the higher level government should adopt the gradient strategy to reduce direct input, strive for the rational allocation of resources to maximize the effectiveness, and avoid the waste of resources.
- (2) Increasing the negative benefits of social organizations and poverty groups will affect the evolution of tripartite competition. As rational people, each game subject will try to reduce their own losses. If the negative return (penalty) is increased moderately, the participants will consider the cost and choose the cooperative strategy to pursue the benefit. Therefore, moderately increasing the negative income of social organizations and poverty groups can restrain the behavioural strategies of both sides and promote the

process of poverty alleviation. However, the appropriate range of punishment is still pending question.

- (3) Increasing the basic economic benefits of social organizations and poverty groups will significantly affect the evolution of tripartite competition. Whether poverty groups choose to actively lift themselves out of poverty depends on the stimulus of economic benefits brought by poverty alleviation. The social organizations in this paper belong to for-profit organizations and are eager to use their own advantages to get additional economic growth. Considering the cost of poverty alleviation paid by social organizations and giving reasonable compensation to social organizations through some policy incentives can promote the good operation of social organizations.

The above research conclusions have a certain reference value for the multisubject collaborative governance of targeted poverty alleviation. The countermeasures and suggestions are as follows. Firstly, we should clearly establish a gradient subsidy support mechanism to avoid direct input. Secondly, the participation of multiple agents is promoted by means of a dual mechanism of punishment and incentive. Thirdly, the supervision and evaluation system of social organizations should be improved to clearly define the power and responsibility relationship between government and social organizations. Fourthly, strengthen the publicity and guidance of social organizations and institutional buildings and actively respond to the participation of the whole people in poverty alleviation. This paper only considers the evolutionary game model involved with three parties, and the cooperative governance of more parties should be further discussed in the future.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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